EDMC # 47718

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ACCESSION # D197244006

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ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 635536

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. USQ Required?	5. Date
Supplemental [] Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	Jim G. Field, Data Assessment and Interpretation, R2-12, 376-3753	[] Yes [X] No	08/07/97
	6. Project Title/No./Work Order No.	7. Bldg./Sys./Fac. No.	8. Approval Designator
	Tank 241-T-105	241-T-105	N/A
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.)	10. Related ECN No(s).	11. Related PO No.
	HNF-SD-WM-ER-369, Rev. 1	ECN-635417	N/A

12a. Modification Work	12b. Work Package No.	12c. Modification Work Complete	12d. Restored to Original Condition (Temp. or Standby ECN only)
[] Yes (fill out Blk. 12b) [X] No (NA Blks. 12b, 12c, 12d)	N/A	N/A Design Authority/Cog. Engineer Signature & Date	N/A Design Authority/Cog. Engineer Signature & Date

13a. Description of Change

13b. Design Baseline Document? [] Yes [X] No

This ECN was generated to include additional explanatory text in the best-basis narrative, and to update the comprehensive radionuclide inventory estimates for the tank.

14a. Justification (mark one)

Criteria Change	[]	Design Improvement	[X]	Environmental	[]	Facility Deactivation	[]
As-Found	[]	Facilitate Const	[]	Const. Error/Omission	[]	Design Error/Omission	[]

14b. Justification Details

Initial release of this document was deficient.

15. Distribution (include name, MSIN, and no. of copies)

See attached distribution.

RELEASE STAMP

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ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1) ECN-635536

16. Design Verification Required	17. Cost Impact				18. Schedule Impact (days)	
	ENGINEERING		CONSTRUCTION			
[] Yes	Additional	[] $	Additional	[] $	Improvement	[]
[X] No	Savings	[] $	Savings	[] $	Delay	[]

19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

SDD/DD	[]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]
Functional Design Criteria	[]	Stress/Design Report	[]	Health Physics Procedure	[]
Operating Specification	[]	Interface Control Drawing	[]	Spares Multiple Unit Listing	[]
Criticality Specification	[]	Calibration Procedure	[]	Test Procedures/Specification	[]
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]
Equipment Spec.	[]	Maintenance Procedure	[]	ASME Coded Item	[]
Const. Spec.	[]	Engineering Procedure	[]	Human Factor Consideration	[]
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]
Vendor Information	[]	Operating Procedure	[]	Electric Circuit Schedule	[]
OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]
Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[]
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]	Tickler File	[]
Environmental Report	[]	Inspection Plan	[]		[]
Environmental Permit	[]	Inventory Adjustment Request	[]		[]

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number Revision
N/A		

21. Approvals

Signature		Date	Signature	Date
Design Authority			Design Agent	
Cog. Eng. J.G. Field	J G Field	8/20/97	PE	
Cog. Mgr. K.M. Hall	Kathleen M. Hall	8/20/97	QA	
QA			Safety	
Safety			Design	
Environ.			Environ.	
Other			Other	
			DEPARTMENT OF ENERGY	
			Signature or a Control Number that tracks the Approval Signature	
			ADDITIONAL	

Tank Characterization Report for Single-Shell Tank 241-T-105

Jim G. Field
Lockheed Martin Hanford, Corp., Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

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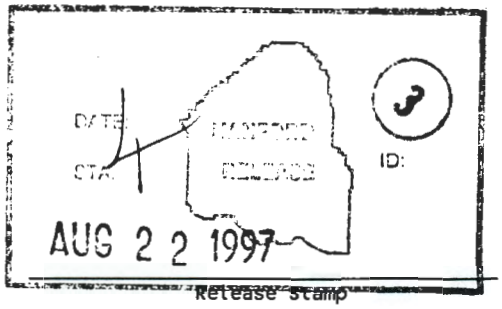
Key Words: Waste Characterization, Single-Shell Tank, SST, Tank 241-T-105, 241-T-105, T-105, T Farm, Tank Characterization Report, TCR, Waste Inventory, TPA Milestone M-44

Abstract: This document summarizes the information on the historical uses, present status, and the sampling and analysis results of waste stored in Tank 241-T-105. This report supports the requirements of the Tri-Party Agreement Milestone M-44-05.



Release Approval Date Release Stamp

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RECORD OF REVISION	(1) Document Number HNF-SD-WM-ER-369	Page 1

(2) Title
Tank Characterization Report for Single-Shell Tank 241-T-105

CHANGE CONTROL RECORD

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		(5) Cog. Engr.	(6) Cog. Mgr. Date
0	(7) Initially released on EDT 159082	B. C. Simpson	C. S. Haller
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		J. G. Field 8/20/97	Kathleen M Hall 8/20/97

3.0 BEST-BASIS INVENTORY ESTIMATE

Information about the chemical and/or physical properties of tank wastes is used to perform safety analyses, engineering evaluations, and risk assessments associated with waste management activities, as well as to address regulatory issues. Waste management activities include overseeing tank farm operations and identifying, monitoring, and resolving safety issues associated with these operations and with the tank wastes. Disposal activities involve designing equipment, processes, and facilities for retrieving wastes and processing the wastes into a form that is suitable for long-term storage.

Chemical inventory information generally is derived using two approaches: 1) component inventories are estimated using the results of sample analyses; and 2) component inventories are predicted using a model based on process knowledge and historical information. The most recent model was developed by Los Alamos National Laboratory (LANL) (Agnew et al. 1997). Not surprisingly, information derived from these two different approaches is often inconsistent.

An effort is underway to provide waste inventory estimates that will serve as standard characterization information for the various waste management activities (Hodgson and LeClair 1996). Appendix D contains the complete narrative regarding the derivation of the inventory estimates presented in Tables 3-1 and 3-2.

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-T-105 (September 30, 1996). (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, E or C)[1,2]	Comment
Al	17,000	E	
Bi	7,500	E	
Ca	2,200	S	
Cl	240	S	Based on analysis of water leach only
CO_3	17,200	S	
Cr	360	E	
F	1,200	E	
Fe	8,600	E	
Hg	1	M	Poor sample basis
K	190	S	
La	0	M	Poor sample basis

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-T-105 (September 30, 1996). (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, E or C)[1,2]	Comment
Mn	7,000	S	Likely to be much lower
Na	38,000	E	Based on analysis of leach water only
Ni	28	M	Poor sample basis
NO_2	4,000	E	Based on analysis of leach water only
NO_3	31,000	E	Based on analysis of leach water only
OH	42,500	C	charge balance calculation
Pb	280	S	
P as PO_4	20,000	E	
Si	4,300	E	
S as SO_4	5,800	E	
Sr	85	S	
TOC	0	M	Poor sample basis
U_{Total}	1,000	E	
Zr	21	E	

Notes:

[1]S = Sample-based, M = Hanford Defined Waste model-based, E = Engineering assessment-based from tanks 241-T-104, 241-B-111, and 241-U-204, C = Calculated by charge balance; includes oxides as hydroxides, not including CO_3, NO_2, NO_3, PO_4, SO_4, and SiO_3.

[2]Sample based inventories were based on partial cores with poor recovery (see Appendix B).

Table 3-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-T-105, Decayed to January 1, 1994 (Effective September 30, 1996). (3 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M,E, or C)[1,2]	Comment
^{3}H	7.6	S	
^{14}C	0.61	S	Based on analysis of water leach only.
^{59}Ni	0.0048	M	

Table 3-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-T-105, Decayed to January 1, 1994 (Effective September 30, 1996). (3 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M,E, or C)[1,2]	Comment
^{60}Co	23	S	
^{63}Ni	0.435	M	
^{79}Se	0.00357	M	
^{90}Sr	170000	S	
^{90}Y	170000	S	
^{93m}Nb	0.0142	M	
^{93}Zr	0.0169	M	
^{99}Tc	230	S	Based on analysis of water leach only.
^{106}Ru	1.88 E-09	M	
^{113m}Cd	0.0426	M	
^{125}Sb	400	S	
^{126}Sn	0.00538	M	
^{129}I	2.22 E-04	M	
^{134}Cs	1.71 E-04	M	
^{137m}Ba	28400	S	From ^{137}Cs
^{137}Cs	30000	S	
^{151}Sm	13.2	M	
^{152}Eu	0.00586	M	
^{154}Eu	1000	S	
^{155}Eu	1100	S	
^{226}Ra	8.76 E-07	M	
^{227}Ac	4.49 E-06	M	
^{228}Ra	2.25 E-11	M	
^{229}Th	4.37 E-09	M	
^{231}Pa	9.88 E-06	M	
^{232}Th	4.74 E-12	M	
^{232}U	3.60 E-05	M	
^{233}U	1.67 E-06	M	
^{234}U	1.56	M	
^{235}U	0.0688	M	
^{236}U	0.0155	M	

Table 3-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-T-105, Decayed to January 1, 1994 (Effective September 30, 1996). (3 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M,E, or C)[1,2]	Comment
^{237}Np	7.28 E-04	M	
^{238}Pu	0.106	M	
^{238}U	1.58	M	
$^{239/240}Pu$	84	S	
^{239}Pu	24.9	M	
^{240}Pu	1.68	M	
^{241}Am	520	S	
^{241}Pu	2.66	M	
^{242}Cm	1.07 E-04	M	
^{242}Pu	1.11 E-05	M	
^{243}Am	2.64 E-07	M	
^{243}Cm	2.19 E-06	M	
^{244}Cm	6.26 E-06	M	

[1]S=Sample-based
M=Hanford Defined Waste model-based
E=Engineering assessment-based

[2]Sample based inventories were based on partial cores with poor recovery (see Appendix B).

APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-T-105

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-T-105

The following evaluation provides a best-basis inventory estimate for chemical and radionuclide components in tank 241-T-105.

D1.0 IDENTIFY/COMPILE INVENTORY SOURCES

Characterization results from the most recent sampling event for this tank are in Appendix B. These results are based on two core samples (cores 53 and 54) obtained in 1993. Waste recovery was incomplete for both cores. As a result, the estimated sample inventories are based only on segment 1 of the 2 segment core samples. The solids recovery for segment 2 was especially low. Analyses indicate the waste is strongly heterogeneous. The HDW model document (Agnew et al. 1996a) provides tank content estimates, derived from the LANL model, in terms of component concentrations and inventories.

D2.0 COMPARE COMPONENT INVENTORY VALUES AND NOTE SIGNIFICANT DIFFERENCES

Sampling-based inventories derived from the analytical concentration data (see Section B3.4), and HDW model inventories generated by the LANL HDW model (Agnew et al. 1996), are compared in Tables D2-1 and D2-2. (The chemical species are reported without charge designation per the best-basis inventory convention). The tank volume used to generate these inventories is 371 kL (98 kgal). This volume which is reported in Hanlon (1996) is the same as that reported by Agnew et al. (1996a). The density used to calculate the sampling inventory estimate is 1.64 g/mL, based on sample measurements, which is higher than the value reported in Agnew et al. (1996a). The HDW model density is estimated to be 1.24 g/mL. Note the significant differences between the sampling-based and HDW model inventories for several bulk components, for example, Al, Bi, Mn. This indicates the sample represents CW waste and probably does not represent the 2C waste type.

Table D2-1. Sample- and Historical Tank Content-Based Inventory Estimates for Nonradioactive Components in Tank 241-T-105. (2 sheets)

Analyte	Sample Concentration (μg/g)	Sampling Inventory Estimate[1] (kg)	HDW Model Inventory Estimate[2] (kg)
Ag	46	28	nr
Al	95,100	58,000	2,300
B	335	200	nr
Bi	1,330	810	6,200
Ca	3,670	2,200	1,800
Cd	15.4	9.4	nr
Cl	402	240	270
Cr	505	310	69
F	1.26[3] μg/mL	0.5	1,200
Fe	33,100	20,000	9,500
Hg	23.9	14	1.1
K	305	190	65
La	24.3	16	0
Mn	11,600	7,000	0
Na	56,300	30,000	34,000
Ni	81	49	28
NO_2	29,800	18,000[3]	1,100
NO_3	21,200	13,000[3]	19,000
OH	nr	<760	13,000
Pb	453	280	0
P as PO_4	4,690	2,800	34,500
Si	6,980	4,200	740
S as SO_4	7,860	4,800	1,500
Sr	141	85	0

Table D2-1. Sample- and Historical Tank Content-Based Inventory Estimates for Nonradioactive Components in Tank 241-T-105. (2 sheets)

Analyte	Sample Concentration (μg/g)	Sampling Inventory Estimate[1] (kg)	HDW Model Inventory Estimate[2] (kg)
TIC as CO_3	28,400[3]	17,200	2,600
TOC	4,590	2,800	0
U_{total}	9,140	5,600	20
Zr	119	72	63
H_2O (wt%)	44	44	72
Density (kg/L)	1.64	1.64	1.24

Notes:

nr = not reported

[1]Field et al. (1997)
[2]Appendix E of Agnew et al. (1996a)
[3]Based on analysis of water leach only.

Table D2-2. Sample- and Historical Tank Content-Based Inventory Estimates for Radioactive Components in Tank 241-T-105.[1]

Analyte	Sample Concentration μCi/g	Sampling Inventory Estimate[2] (Ci)	HDW Model Inventory Estimate[3] (Ci)
^{241}Am	0.857	520	nr
^{125}Sb	0.665	400	nr
^{14}C[4]	0.001	0.61	nr
^{134}Cs	<0.055	<33.5	nr
^{137}Cs	43.9	30,000	2,930
^{60}Co	0.038	23	nr
^{154}Eu	1.79	1,100	nr
^{155}Eu	2.11	1,300	nr
^{238}Pu	2.45E-4	<0.149	nr
$^{239/240}Pu$	0.138	84	6.1
^{90}Sr	280	1.7E+05	28
^{99}Tc[4]	0.372	230	nr
^{3}H	0.012	7.6	nr
Total alpha	0.65	393	nr
Total beta	860	5.2E+05	nr

Notes:

nr = not reported

[1]Curie values decayed to January 1, 1994
[2]Field et al. (1997)
[3]Appendix E of Agnew et al. (1996a)
[4]Based on analysis of water leach only.

D3.0 REVIEW AND EVALUATION OF COMPONENT INVENTORIES

The following evaluation of tank contents was performed to identify potential errors and/or missing information that would influence the sampling-based and HDW model component inventories.

D3.1 CONTRIBUTING WASTE TYPES

The following abbreviations were used to designate waste types:

1C	=	first decontamination cycle $BiPO_4$ waste
2C	=	second decontamination cycle $BiPO_4$ waste
RCW	=	REDOX process aluminum cladding waste
CW	=	$BiPO_4$ process aluminum cladding waste.

Tank 241-T-105 is the middle tank in a cascade that includes tanks 241-T-104 and 241-T-106. In 1946, tank 241-T-105 began receiving 2C waste (Anderson 1990, Agnew et al. 1996b). The waste was sent directly from T Plant to tank 241-T-105, bypassing tank 241-T-104. The 2C waste cascaded from tank 241-T-105 to 241-T-106 when tank 241-T-105 was full.

In 1948, the cascade line from tank 241-T-104 to tank 241-T-105 was used to transfer 1C waste from tank 241-T-104. This 1C waste was combined with cladding waste from the removal of Al fuel element cladding. The cladding waste comprised about 7 percent of the 1C/CW waste stream. The cascade from tank 241-T-104 to tank 241-T-105 was used for transfer of 1C/CW waste until the last additions of 1C/CW waste from T Plant in 1954. In 1954, supernatant in tank 241-T-105 was transferred to cribs.

Beginning in 1955 and until 1956, only CW was sent directly to tank 241-T-105. This waste settled in the tank until 1967 when the supernate was transferred to cribs. Agnew et al. (1996a) defines the origin of the cladding waste from the REDOX process (RCW), whereas Anderson (1990) targets the cladding waste as CW from the $BiPO_4$ process. Further evaluation of waste transaction records in Agnew et al. (1996b) suggests $BiPO_4$ CW was added rather than RCW. However, the measurable difference between the two types of cladding waste is probably negligible.

In 1967, tank 241-T-105 was filled with dilute 300 Area laboratory waste. Much of the supernatant in tank 241-T-105 was sent to the 242-T Evaporator in 1967 and 1968.

Additional dilute wastes were sent to tank 241-T-105 from 1968 to 1973. These waste types probably did not contribute significantly to the tanks' solids volume. These wastes consisted of decontamination waste from T Plant, some supernate transferred from other single-shell tanks, and B Plant low-level waste and ion exchange waste. In 1974, most of the supernate was transferred from tank 241-T-105.

Based on this process history, it is expected that 2C waste fills the tank bottom. The 1C waste makes up another layer. The records indicate that cladding waste may reside above the 1C waste. As summarized below, Anderson (1990) and Hill et al. (1995) predict that some cladding waste is present in tank 241-T-105 (not mixed with 1C waste). However, Agnew et al. (1996a) predicts the presence of only 1C and 2C waste, claiming the majority of the cladding waste solids were transferred to cribs along with the supernatant in 1967.

Expected Solids in Waste

Anderson (1990), SORWT (Hill et al. 1995): 1C, 2C, CW
Agnew et al. (1996a), Agnew et al. (1996b): 1C, 2C

Model-Based Predicted Current Inventory (Agnew et al. 1996a)

Waste Type	Waste Volume kL (kgal)
1C2	98 (26)
2C2	273 (72)

The analytical results for tank 241-T-105 indicate much higher concentrations of aluminum and lower concentrations of bismuth in the waste solids than would be predicted from waste that contained only 1C and 2C waste from the $BiPO_4$ process. These results suggest a significant proportion of the waste that was sampled consists of cladding waste which contains the precipitated aluminum resulting from neutralization of the dissolved aluminum fuel cladding. The analysis provides evidence that CW exists in tank 241-T-105. Agnew et al. (1996a) does not predict any CW beyond that mixed with the 1C waste in the tank.

The waste transaction record (Agnew et al. 1996b) shows that 980 kL (259 kgal) of cladding waste was introduced into the tank during 1955 and 1956. Although the transaction records show that this waste was removed in 1967, it is likely that a significant portion of the precipitated solids remained on the waste surface. If it is assumed the solids content of the neutralized waste is 7 volume percent, a maximum of approximately 79 kL (21 kgal) of CW could remain in the tank. As noted earlier, these cladding waste solids are expected to originate from the $BiPO_4$ process rather than the REDOX process.

D3.2 EVALUATION OF TECHNICAL FLOWSHEET INFORMATION

Waste compositions from flowsheets for 1C, 2C, and CW waste streams are provided in Table D3-1. The comparative LANL defined 1C and 2C waste streams from Agnew et al. (1996a) are also provided in this table. Agnew et al. (1996a) does not indicate CW waste in tank 241-T-105. As shown in Table D3-1, the aluminum concentration in the 1C2 defined waste stream (Agnew et al. 1996a) is approximately a factor of three higher than the flowsheet composition. Based on information in Schneider (1951) it is thought that the 1C waste stream contained approximately 7 volume percent cladding waste, which is about a third of that estimated in Agnew et al. (1996a).

Table D3-1. Technical Flowsheet and Los Alamos National Laboratory Defined Waste Streams.

Analyte	Flowsheet 1C[1] (M)	HDW Model 1C2[2] (M)	Flowsheet 2C[1] (M)	HDW Model 2C1[2] (M)	Flowsheet CW[3] (M)
NO_3	1.44	0.588	0.987	1.24	0.73
NO_2	0.058	0.174	0	0	0.82
SO_4	0.063	0.0616	0.06	0.05	0
PO_4	0.258	0.334	0.241	0.21	0
F	0.170	0.228	0.154	0.22	0
Bi	0.012	0.014	0.00623	0.01	0
Fe	0.032	0.046	0.03	0.04	0
Si	0.031	0.038	0.0257	0.037	0.041
U	0.00096	0.0007	2.4E-5	0.0001	0.0072
$Cr^{+3/+6}$	0.0033	0.0052	0.00123	0.0042	0
Ce	0.00019	0	0	0	0
Na	2.17	2.17	1.59	2.27	3.79
K	0	0.0034		0.0065	
Hg	0	2E-05	0	0	0
Zr	0.0003	0.004	0	0	0
Al	0.083	0.233	0	0	1.17

Notes:

[1]Schneider (1951); assumes 1C waste contains approximately 7 percent CW.

[2]Appendix B of Agnew et al. (1996a); assumes 1C waste contains approximately 24 percent CW.

[3]Schneider (1951).

D3.3 ASSUMPTIONS FOR RECONCILING WASTE INVENTORIES

Reference inventories of components in tank 241-T-105 were estimated using an independent assessment that is based on a set of simplified assumptions. The predicted inventories were then compared with the tank 241-T-105 sampling-based inventories and the HDW model inventories. The assumptions and observations for the engineering assessment were based on best technical judgement pertaining to parameters that can significantly influence tank inventories. These parameters include: (1) correct prediction of contributing waste types and correct relative proportions of the waste types; (2) accurate predictions of model flowsheet conditions, fuel processed, and waste volumes; (3) accurate prediction of partitioning of components; (4) accurate predictions of physical parameters such as density, percent solids, void fraction (porosity), etc.

Using this evaluation, the assumptions/bases can be modified as necessary to provide a means for identifying and reconciling potential errors and/or missing information that could influence the sampling- and model-based inventories. The simplified assumptions and observations used for the evaluation are listed below. The derivation of these assumptions and observations are provided in subsequent paragraphs.

1. Because of the biased analytical data for tank 241-T-105, tanks 241-T-104 and 241-B-111, which contain only one waste type (1C and 2C, respectively), helped provide the analytical basis for inventories for the 1C and 2C waste types. Tank 241-U-204 provides the basis for CW.

2. The 1C, 2C, and CW waste streams contributed to solids formation. The 1C waste stream contained 7 volume percent of CW from the $BiPO_4$ process. The relative proportions of 1C, 2C, and CW used for comparison were, respectively, 216 kL (57 kgal) 2C, 76 kL (20 kgal) 1C, and 79 kL (21 kgal) CW.

3. The components listed in the technical flowsheets summarized in Table D3-1 were used for the evaluation.

4. Tank waste mass is calculated using the tank volume listed in Hanlon (1996). Both the analytical-based and the model-based inventories use equivalent volumes of 371 kL (98 kgal). As a result, inventory comparisons are made on the same total volume basis.

5. All Bi, Fe, Al, Si, Ce, and U precipitate as water insoluble components based on analytical data for tanks 241-B-111, 241-T-104 and 241-U-204. The HDW model predicts varying solubilities for these components.

6. The precipitated solids are concentrated by a factor of 10 in 1C waste (equivalent to 10 volume percent solids) and 20 for 2C waste (equivalent to 5 volume percent solids) and 8 for CW (equivalent to 16 volume percent solids). The concentration factors (CFs) for 1C and 2C waste are based on inventory evaluations for tanks 241-T-104 and 241-B-111, respectively. The CF for CW is based on the inventory evaluation for tank 241-U-204.

7. Sodium, NO_3, NO_2, PO_4, $S0_4$, Cr, and F partition between the liquid and solid phases. This assumption is based on the behavior of these components in tanks 241-T-104, 241-B-111, and 241-U-204.

8. No radiolysis of NO_3 to NO_2 and no additions of NO_2 to the waste for corrosion purposes are factored into this independent assessment.

D3.4 VOLUME RATIO OF WASTE TYPES

The HDW model predicts 98 kL (26 kgal) of 1C waste and 273 kL (72 kgal) of 2C waste in tank 241-T-105. As noted earlier, analytical information indicates that $BiPO_4$ process CW also may comprise a portion of the total waste. Because all three waste types (1C, 2C, and CW) in tank 241-T-105 contain common chemical constituents, it is difficult to predict the relative proportion of the waste types, particularly considering the bias of the analytical data. For this assessment, the volume of 1C and 2C waste in the tank was determined by multiplying the ratios predicted by Agnew et al. (1996a) for 1C and 2C waste (27 volume percent 1C, 73 volume percent 2C), by the total volume of waste in the tank, less 79 kL (21 kgal) attributed to CW waste (ie. 371-79 kL). The resulting assumed volumes for each waste type are provided in Assumption 2 of Section D3.3.

D3.5 METHODOLOGY FOR ESTIMATING TANK 241-T-105 INVENTORY

The sample-based inventories for tank 241-T-105 do not represent the entire tank contents. In addition, the process history for this tank is not adequately defined to enable an estimate of waste component inventories. However, the known waste types in tank 241-T-105 (1C, 2C, and CW) have been sufficiently characterized in other tanks to enable this information to be used as a basis for predicting the inventory in tank 241-T-105. Thus, inventories calculated for tanks 241-T-104 (1C waste), 241-B-111 (2C waste), and 241-U-204 (CW waste), provided the basis for most of the tank 241-T-105 estimates.

Caution should be taken when assuming that the chemical composition for a particular waste type in one tank can be used for that waste type in other tanks. Although this assumption has been shown to be valid for some tanks, particularly for those in a cascade arrangement, component concentrations in a particular waste type may not always be comparable to other waste tanks because of the large variation in the waste volumes flowing through the tanks,

variations in solids and liquid ratios resulting from cascade and cribbing procedures, and the potential for chemical reactions (for example, metathesis) of components when mixed/diluted with other waste types. However, without suitable analytical data and/or process history records for tank 241-T-105, this method was used as the basis for predicting the tank inventory.

The inventories in tanks 241-T-104, 241-B-111, and 241-U-204 were estimated using two approaches. The first approach uses process history knowledge. The inventories for tank components were predicted based on knowledge of the process flowsheets that generated the waste streams, and the total throughput of the waste to the tank. Using this process history method, inventories in waste solids were estimated for components that are expected to precipitate 100 percent from solution (for example, Bi, Fe, Si).

Another method for predicting a component inventory for a particular waste type in a tank (for example, 1C waste) is to derive a concentration factor for that component. This approach also was used to estimate inventories in tanks 241-T-104, 241-B-111, and 241-U-204. The CF is derived by dividing the concentration of a component found in the tank samples by the concentration of that component in the neutralized process waste stream (that is, flowsheet concentrations in Table D3-1). The CF for components of a defined waste are best determined if the tank contains only one waste type (for example, only 1C waste in tank 241-T-104) or when abundant representative analytical data are available. Components expected to precipitate 100 percent based on chemical knowledge should exhibit nearly the same CFs. The relative concentration of fully precipitated components in the waste solids are in proportion to the respective flow sheet concentration for those components. If this is the case, it can generally be concluded that the analytical data represent tank contents.

After the CFs for fully precipitated components for a waste type are determined, the sample analysis can be used to establish how other components such as Cr, SO_4, or PO_4 partition between solids and supernatants. For example, if the CF for Bi, Fe, and Si are determined to be approximately 10 for 1C waste, and the CF for PO_4 is 4.0, then it can be concluded that 40 percent of the PO_4 in the neutralized process waste partitions to the waste solids, that is, the partitioning factor (PF) is 0.4.

When the process history method and CF method are applied to tanks 241-T-104, 241-B-111, and 241-U-204, they provide consistent inventory predictions and conclude that the sample analyses provide the best inventory basis for these tanks. Based on tank sample data, the derived CFs and PFs for tank 241-T-104, 241-B-111 and 241-U-104 are shown in Table D3-2. The following calculations provide estimates of tank 241-T-105 inventories based on these factors.

Table D3-2. Concentration Factors and Partitioning Factors for 1C, 2C, and CW Waste Types.

Component	Concentration Factor			Partition Factor[1]		
	1C[2]	2C[3]	CW[4]	1C	2C	CW
Bi	10	20	na	1	1	na
Fe	10	20	na	1	1	na
Si	10	20	6	1	1	1
U	10	20	6	1	1	1
Cr	6.7	20	na	0.67	1	na
Ce	10	na	na	na	na	na
Al	10	na	6	1	na	1
Zr	10	na	na	1	na	na
Na	1.6	3.1	1.2	0.16	0.15	0.2
SO_4	0.8	4.3	na	0.08	0.22	na
PO_4	4	2.5	na	0.40	0.13	na
F	3.4	0.83	na	0.34	0.03	na
NO_3	0.83	1.6	1.2	0.08	0.08	0.2
NO_2	2.0	na	1.2	0.20	na	0.2

Notes:

na = not applicable

[1]Fraction of flowsheet component precipitating in waste solids. Includes interstitial liquors associated with solids.

[2]Based on tank 241-T-104

[3]Based on tank 241-B-111

[4]From RCW tank 241-U-204

D3.6 ESTIMATED INVENTORY OF COMPONENTS

The following calculations provide estimates of tank 241-T-105 inventories for components.

Components Assumed to Precipitate 100 percent.

Bi: [.00623 moles Bi/L_{2C} x 57 kgal x $20_{CF(2C)}$ + 0.012 moles Bi/L_{1C} x 20 kgal x $10_{CF(1C)}$] x [3,785 L/kgal x 209 g/mole Bi x MT/1E+06] = 7.5 MT

Fe: [0.032 moles Fe/L_{1C} x 20 kgal x $10_{CF(1C)}$ + 0.03 moles Fe/L_{2C} x 57 kgal x $20_{CF(2C)}$] x [3,785 L/gal x 55.85 g/mole Fe x MT/1E+06] = 8.6 MT

Similarly:

Si: 4.3 MT

Zr: 0.021 MT

Ce: 0.020 MT

U: 1.0 MT

Al: 17 MT

Components Assumed to Partition Between Aqueous and Solid Phases

Na: [2.17 moles Na/L_{1C} x 20 kgal x 10_{CF} x 0.16 PF + 1.59 moles Na/L_{2C} x 57 kgal x 20 CF x 0.15 PF + 3.79 moles Na/L_{CW} x 21 kgal x 6CF x 0.2 PF] 3,785 L/kgal x 23 g/mole Na x MT/1.0E+06 g = 38 MT

Similarly:

Cr: 0.36 MT

SO_4: 5.8 MT

PO_4: 20 MT

F: 1.2 MT

NO_3: 31 MT

NO_2: 4.0 MT

Estimated component inventories from this evaluation are compared with the sample from tank 241-T-105 and HDW model-based inventories in Table D3-3. Observations regarding these inventories are noted, by component, in the following text.

Bismuth. The reference inventory predicted by this assessment is comparable to the HDW model-based inventory. The sample-based inventory is derived from incomplete sample recovery. It does not represent the entire tank content and is probably biased towards CW. The 1C and 2C defined wastes from the HDW model do not differ significantly from the 1C and 2C flowsheet basis (see Table D3-1). The HDW model assumes that significantly less Bi in the 1C2 and 2C1 stream precipitated (approximately 70 percent) than is assumed for the comparable waste streams for this independent assessment. However, the HDW model predicts a larger volume of 2C waste in this tank. Consequently the predicted inventories for the HDW model and this assessment are comparable.

Table D3-3. Comparison of Selected Component Inventory Estimates for Tank 241-T-105 Waste.

Component	This evaluation (kg)	Sample-based (kg)	HDW model (kg)
Bi	7,500	810	6,200
Cr	360	310	69
Fe	8,600	20,000	9,500
K	0	190	65
Al	17,000	58,000	2,300
Mn	0	7,000	0
Na	38,000	30,000	34,000
Si	4,300	4,200	740
Zr	21	72	63
U	1,000	nr	20
F	1,200	0.51	1,200
NO_3	31,000	13,000[1]	19,000
NO_2	4,000	18,000[1]	1,100
PO_4	20,000	2,800	34,500
SO_4	5,800	4,800	1,500
H_2O (%)		44	76,000

Note:

[1]Based on analysis of water leach only

Chromium. This inventory assessment predicted the total Cr content to be close to that based on the sample analysis. However, these values are approximately four-fold higher than that predicted by the HDW model. The HDW model-defined waste streams indicate slightly higher concentrations of chromium in the 1C and 2C wastes than given in Schneider (1951) (see Table D3-1). These concentrations may be somewhat inflated from the corrosion source-terms assumed for the HDW model; no corrosion source term was used in this assessment. However, the HDW model assumes that no Cr precipitated in the 1C and 2C stream; that is, the only Cr contribution to the solids is from the interstitial liquids associated with the solids. Because the Cr was added primarily as Cr III in the $BiPO_4$ process, it is expected that the majority of the chromium will precipitate as $Cr(OH)_3$ or $Cr_2O_3 \cdot XH_2O$. The presence of Cr in the sample analysis for tank 241-T-105 is higher than expected if the sample is predominantly CW. However, other indications, based on the analyses, suggest some mixing of the 1C and 2C wastes with the CW.

Iron. The reference Fe inventory predicted by this assessment is somewhat smaller than for the HDW model inventory. This evaluation does not predict a corrosion source-term for Fe, and may explain the smaller inventory for this assessment.

The analytical-based inventory for Fe is much higher. If the sample is predominantly CW, no Fe should be expected except from corrosion. Iron additions from the 1C and 2C flowsheet should not account for this much Fe. The higher density basis used for calculations and/or much higher corrosion than expected are possible explanations for the higher analytical values.

Aluminum. The Al inventory predicted by this independent assessment and the sample-based Al inventory are significantly higher than that predicted by the HDW model. The sample-based inventory represents primarily CW and probably does not represent the entire tank. The estimated Al for the tank is approximately eight-fold higher than that predicted by the HDW model. This assessment assumes 100 percent of the Al in the 1C and CW waste partitions to the solids (based on tanks 241-T-104 and 241-U-204). The HDW model assumes that only a small percent of the Al partitions to the solids in 1C2 waste. The HDW model does not predict CW (which contains significant amounts of Al) in the tank.

Manganese. This assessment and the HDW model predict no Mn in tank 241-T-105. Records do not indicate additions of Mn as part of the flowsheet. However, significant quantities of Mn were detected in the sample. The source may be waste from decontamination of equipment at T Plant using $KMnO_4$. Agnew et al. (1996b) shows that decontamination waste was added to tank 241-T-105 in 1968 and 1969. Based on the sample analysis (which probably does not represent the entire tank) a total of 7.0 MT Mn is present. It is expected that the inventory of Mn is significantly less than 7.0 MT.

Sodium. The small amount of Na assumed in this assessment to partition to the solids results in an estimated inventory that compares well with the HDW model.

Silicon. The reference Si inventory predicted by this assessment compares well with the sample-based inventory but is approximately five times that predicted by the HDW model. The apparent explanation is that this assessment assumes that all Si precipitates, and the HDW model assumes a significant portion of the Si is in the aqueous stream sent to cribs. In addition, the HDW model does not predict CW waste (which contains significant amounts of Si in the tank.

Fluoride. The reference inventory predicted by this assessment and the HDW model inventory are comparable, but the inventory based on the tank 241-T-105 samples is much lower. This assessment assumed that a small fraction of the F in the tank remains as insoluble compounds. The analytical-based inventory results from analysis of the aqueous portion generated from water leaching of the sample. The water insoluble solids may contain F, but it is not possible to determine how much until an analytical method that measures total F is used. It is not surprising that the sample-based inventory for fluoride is quite low because it is suspected that the sample represented primarily CW.

Potassium. The flowsheets for 1C, 2C, and CW (see Table D3-1) do not indicate additions of K as part of the flowsheets. The HDW model shows K in the 1C defined waste. It is probably present as a contaminant from sodium hydroxide which was used to neutralize the acidic wastes. Analyses indicate the presence of K, thus providing substantive evidence that K entered the tank as a contaminant. In addition, evidence shows (Agnew et al. 1996b) that K may have been added (as $KMnO_4$) from decontamination activities at T Plant.

Nitrate. The NO_3 inventory predicted by this assessment is approximately 50 percent higher than that predicted by the HDW model. The HDW model assumes all NO_3 remains in the aqueous phase, and this assessment assumes (based on tanks 241-T-104 and 241-B-111) that some NO_3 partitions to the solids. The sample-based inventory for NO_3 is significantly lower. However, because the sample-based inventory probably represents CW, the concentration of NO_3 is expected to be lower (see Table D2-1).

Nitrite. This assessment does not account for any NO_2 from radiolysis of NO_3 or any NO_2 additions for corrosion control purposes. This assessment and the HDW model predict small inventories of nitrite from 1C waste. As would be expected, the sample analysis also indicates NO_2 since it provided a significant contribution to CW.

Phosphate. The PO_4 inventory predicted by this assessment is approximately six times higher than that predicted by the HDW model and sample analyses. The assumptions used in this assessment for partitioning the PO_4 between solid and aqueous phases are based on calculated PFs for tanks that contain only 1C and 2C waste (that is, tanks 241-T-104 and 241-B-111, respectively). These waste types are higher in PO_4 than CW. However, for reasons explained earlier, the PF for components with mixed waste types may vary.

Sulfate. The HDW inventory is only about one-fourth that estimated by this evaluation. The HDW model assumed that the SO_4 partitions entirely to the aqueous phase, and this assessment assumes some SO_4 partitions to the solids based on the inventory evaluations from tanks 241-T-104 and 241-B-111.

Total Hydroxide. Once the best basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valences of other analytes. In some cases this approach requires that other analyte (e.g., sodium or nitrate) inventories be adjusted to achieve the charge balance. During such adjustments the number of significant figures is not increased. This charge balance approach was consistent with that used by Agnew et al. (1997a).

D4.0 DEFINE THE BEST-BASIS AND ESTABLISH COMPONENT INVENTORIES

Information about chemical, radiological, and/or physical properties is used to perform safety analyses, engineering evaluations, and risk assessments associated with waste management activities, as well as regulatory issues. These activities include overseeing tank farm operations and identifying, monitoring, and resolving safety issues associated with these operations and with the tank wastes. Disposal activities involve designing equipment, processes, and facilities for retrieving wastes and processing them into a form that is suitable for long-term storage. Chemical and radiological inventory information are generally derived using three approaches: (1) component inventories are estimated using the results of sample analyses, (2) component inventories are predicted using the HDW model based on process knowledge and historical information, or (3) a tank-specific process estimate is made based on process flowsheets, reactor fuel data, essential material usage and other operating data. The information derived from these different approaches is often inconsistent.

An effort is underway to provide waste inventory estimates that will serve as the standard characterization for management activities (Kupfer et al. 1995). As part of this effort, an evaluation of available chemical information for tank 241-T-105 was performed including the following:

- Data from two core composite samples from tank 241-T-105 collected in 1993.
- Data from three tanks that contain the same waste types (1C, 2C, and CW) as found in tank 241-T-105. The three tanks that represent 1C, 2C, and CW waste are tanks 241-T-104, 241-B-111, and 241-U-204, respectively.
- Inventory estimate generated by the HDW model (Agnew et al. 1996a).

The results from this evaluation support using a predicted inventory based primarily on analytical results for tanks 241-T-104, 241-B-111, and 241-U-204 as the basis for the best-estimate inventory to tank 241-T-105 for the following reasons:

1. Waste transactions based on Anderson (1990) for tank 241-T-105 show significant quantities of CW solids and waste solids from the first and second contamination cycles of the $BiPO_4$ process. The HDW model (Agnew et al. 1996a) predicts only 1C and 2C waste layers in the tank although the analytical data based on the 1993 core samples from tank 241-T-105 are considered poor because solids recovery was low. The analytical results indicate that waste from this sample contained primarily CW.

2. Because waste recovery for the two core samples from tank 241-T-105 was incomplete, it is unlikely that the sample-based inventory represents the entire tank. However, radionuclide distribution in the samples appears to represent the tank, based on heat load estimate.

3. The solubility data in Agnew et al (1996a) for several chemical components are not consistent with the analytical data for tanks that contain only 1C and 2C waste (tanks 241-T-104 and 241-B-111, respectively).

Because of the limited sample recovery, the sample data for tank 241-T-105 are not considered representative of the entire tank contents. As a result, the analytical-based inventories for tanks 241-T-104, 241-B-111, and 241-U-204 were used to derive the best-basis inventory of chemical components that were added to tank 241-T-105 from process flowsheet additions. The analytical results from tanks 241-T-104, 241-B-111, and 241-U-204, which contain only 1C, 2C, and CW, respectively, agree with predicted inventories for these tanks based on process flowsheets and waste fill history. Assessments have shown that the analytical-based compositions for these tanks can be extrapolated to the same waste types in other tanks, particularly if the tanks are in a cascade arrangement. The assumptions regarding the representativeness of tank samples must be considered speculative at this time with resolution provided by possible future resampling of this tank.

Inventories for components, which were not added from the process flowsheets, are based on the core samples from tank 241-T-105. All radionuclide inventories are based on the sample analysis of tank 241-T-105. Radionuclide curie values are decayed to January 1, 1994.

Best-basis inventory estimates for tank 241-T-105 are shown in Tables D4-1 and D4-2. The quality of the estimate for chemical and radionuclide components is considered low because the inventories are either extrapolated from data from other tanks (241-T-105, 241-B-111, and 241-U-204), or they are based on sample results from tank 241-T-105 that are considered biased. The inventory values reported in Tables D4-1 and D4-2 are subject to change. Refer to the Tank Characterization Database (TCD) for the most current inventory values.

Best-basis tank inventory values are derived for 46 key radionuclides (as defined in Section 3.1 of Kupfer et al. 1997), all decayed to a common report date of January 1, 1994. Often, waste sample analyses have only reported ^{90}Sr, ^{137}Cs, $^{239/240}Pu$, and total uranium, or (total beta and total alpha) while other key radionuclides such as ^{60}Co, ^{99}Tc, ^{129}I, ^{154}Eu, ^{155}Eu, and ^{241}Am, etc., have been infrequently reported. For this reason it has been necessary to derive most of the 46 key radionuclides by computer models. These models estimate radionuclide activity in batches of reactor fuel, account for the split of radionuclides to various separations plant waste streams, and track their movement with tank waste transactions. (These computer models are described in Kupfer et al. 1997, Section 6.1 and in Watrous and Wootan 1997.) Model generated values for radionuclides in any of 177 tanks are reported in the Hanford Defined Waste Rev. 4 model results (Agnew et al. 1997). The best-basis value for any one analyte may be either a model result or a sample or engineering assessment-based result if available. (No attempt has been made to ratio or normalize model results for all 46 radionuclides when values for measured radionuclides disagree with the model.) For a discussion of typical error between model derived values and sample derived values, see Kupfer et al. 1997, Section 6.1.10.

Best-basis tables for chemicals and only four radionuclides (^{90}Sr, ^{137}Cs, Pu and U) were being generated in 1996, using values derived from an earlier version (Rev. 3) of the Hanford Defined Waste model. When values for all 46 radionuclides became available in Rev 4 of the HDW model, they were merged with draft best-basis chemical inventory documents. Defined scope of work in FY 1997 did not permit Rev. 3 chemical values to be updated to Rev. 4 chemical values.

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-T-105 (September 30, 1996). (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, E or C)[1,2]	Comment
Al	17,000	E	
Bi	7,500	E	
Ca	2,200	S	
Cl	240	S	Based on analysis of water leach only
CO_3	17,200	S	
Cr	360	E	
F	1,200	E	
Fe	8,600	E	
Hg	1	M	Poor sample basis
K	190	S	
La	0	M	Poor sample basis
Mn	7,000	S	Likely to be much lower
Na	38,000	E	Based on analysis of leach water only
Ni	28	M	Poor sample basis
NO_2	4,000	E	Based on analysis of leach water only
NO_3	31,000	E	Based on analysis of leach water only
OH	42,500	C	charge balance calculation
Pb	280	S	
P as PO_4	20,000	E	
Si	4,300	E	
S as SO_4	5,800	E	
Sr	85	S	
TOC	0	M	Poor sample basis

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-T-105 (September 30, 1996). (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, E or C)[1,2]	Comment
U_{Total}	1,000	E	
Zr	21	E	

Notes:

[1]S = Sample-based, M = Hanford Defined Waste model-based, E = Engineering assessment-based from tanks 241-T-104, 241-B-111, and 241-U-204, C = Calculated by charge balance; includes oxides as hydroxides, not including CO_3, NO_2, NO_3, PO_4, SO_4, and SiO_3.

[2]Sample based inventories were based on partial cores with poor recovery (see Appendix B).

Table D4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-T-105, Decayed to January 1, 1994 (Effective September 30, 1996). (3 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M,E, or C)[1,2]	Comment
^{3}H	7.6	S	
^{14}C	0.61	S	Based on analysis of water leach only.
^{59}Ni	0.0048	M	
^{60}Co	23	S	
^{63}Ni	0.435	M	
^{79}Se	0.00357	M	
^{90}Sr	170000	S	
^{90}Y	170000	S	
^{93m}Nb	0.0142	M	
^{93}Zr	0.0169	M	
^{99}Tc	230	S	Based on analysis of water leach only.
^{106}Ru	1.88 E-09	M	
^{113m}Cd	0.0426	M	
^{125}Sb	400	S	
^{126}Sn	0.00538	M	

Table D4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-T-105, Decayed to January 1, 1994 (Effective September 30, 1996). (3 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M,E, or C)[1,2]	Comment
^{129}I	2.22 E-04	M	
^{134}Cs	1.71 E-04	M	
^{137m}Ba	28400	S	From ^{137}Cs
^{137}Cs	30000	S	
^{151}Sm	13.2	M	
^{152}Eu	0.00586	M	
^{154}Eu	1000	S	
^{155}Eu	1100	S	
^{226}Ra	8.76 E-07	M	
^{227}Ac	4.49 E-06	M	
^{228}Ra	2.25 E-11	M	
^{229}Th	4.37 E-09	M	
^{231}Pa	9.88 E-06	M	
^{232}Th	4.74 E-12	M	
^{232}U	3.60 E-05	M	
^{233}U	1.67 E-06	M	
^{234}U	1.56	M	
^{235}U	0.0688	M	
^{236}U	0.0155	M	
^{237}Np	7.28 E-04	M	
^{238}Pu	0.106	M	
^{238}U	1.58	M	
$^{239/240}Pu$	84	S	
^{239}Pu	24.9	M	
^{240}Pu	1.68	M	
^{241}Am	520	S	
^{241}Pu	2.66	M	
^{242}Cm	1.07 E-04	M	

Table D4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-T-105, Decayed to January 1, 1994 (Effective September 30, 1996). (3 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M,E, or C)[1,2]	Comment
^{242}Pu	1.11 E-05	M	
^{243}Am	2.64 E-07	M	
^{243}Cm	2.19 E-06	M	
^{244}Cm	6.26 E-06	M	

[1]S=Sample-based
M=Hanford Defined Waste model-based
E=Engineering assessment-based

[2]Sample based inventories were based on partial cores with poor recovery (see Appendix B).

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